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Interactions between Monetary Policy^{*} and Fiscal Policy

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Abstract

Using a panel data set of 14 EU countries from 1970 to 2012, we study the type of monetary and fiscal policies of both authorities, and assess how they are influenced by certain economic variables and events (the Maastricht Treaty, the Stability and Growth Pact, the Euro and crises). Results show that inflation has a significant impact on monetary policy, and that governments raise their primary balances when facing increases in debt. Another goal is to characterise the type of interactions established between central banks and national governments, i.e. if their policies complement one another, or whether there is a more dominant one. Still, our results point to the lack of evidence concerning central banks' response to fiscal policy.

JEL: E52, E62, E63, H62.

Keywords: interactions, monetary policy, fiscal policy, reaction functions.

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1. Introduction

On the 7th of February 1992, the Maastricht Treaty was signed, which was the first step towards a common currency among the member states of the European Union (EU). This treaty was established following convergence criteria which each member state was obliged to comply with, based on rules on budget deficit and debt levels, low inflation and interest rates close to the EU average. Thus, it contributed towards achieving price stability and fiscal sustainability.

However, these Maastricht provisions did not seem to be sufficient enough to deal with excessive deficits, which led to the formation of other procedures to complement the creation of the Economic and Monetary Union (EMU). In 1997, members from the EU agreed to the Stability and Growth Pact (SGP), a set of fiscal rules for maintaining and reinforcing low budget deficits, whereby annual government budget deficit and government debt may not exceed 3% and 60% of GDP, respectively. Finally, the third stage of the EMU took place on the 1st of January 1999, with the launch of a common single currency, the Euro, which was to be used as the monetary unit for all transactions by January 2002.

Despite all the advantages that these three economic milestones brought about, they restricted the use of fiscal policy, especially when countries joined the Euro area, lost their individual monetary policy, and became aligned to a common monetary policy. This leads us to need to think about the relationship created between a country's fiscal and monetary policies.

The interactions between fiscal policy and monetary policy are a complex topic to study, as the role of each authority has a different impact on the economy, which could be the reason why equilibrium under these two policies is similarly difficult to determine. Thus, the type of relationship established by both authorities is important in determining how their policies will influence the levels of inflation, debt and economic growth, in other words, all the aspects that are related to the economic performance of a country.

Through this study, our intention is to analyse the impact of certain economic variables on these policies, and to determine whether there is evidence, or not, of Ricardian fiscal regimes. Subsequently, through the reaction functions of each authority, we will also be able to define their main goals and the type of interaction that exists between national governments and central banks. Finally, we plan to see how the

Maastricht Treaty, the SGP, the Euro and crises have influenced monetary and fiscal policies.

For a sample of 14 European countries during the period of 1970-2012, we performed a panel data analysis, which took into account the impact that these policies have on all of the countries, on average. Our results show that inflation is quite relevant for monetary policy, and that primary balance reacts positively to increases in government debt. Moreover, our results point to the lack of evidence concerning central banks' response to fiscal policy.

Furthermore, in relation to these events, the estimation results are all statistically significant for monetary and fiscal policies, but the dummy for the Maastricht Treaty shows that it has the biggest impact on monetary policy, probably due to the convergence criteria. On the other hand, the introduction of the Euro has a greater negative effect on fiscal policy, together with that of a rise in countries' budget deficits. As we expected, crises influence monetary and fiscal policies negatively, but this effect is smoothed out if countries belong to the Euro area. In addition, we also made individual analyses for each country.

The paper is structured as follows: Section 2 provides a brief theoretical and empirical analysis of the background literature, emphasising the different policies and the degree of economic coordination; Section 3 explains the empirical specifications, namely the data and variables used in the model, as well as the econometric approaches chosen; Section 4 details the regressions that were estimated, as well as the empirical results; Section 5 summarises the conclusions.

2. Literature and Theoretical Background

2.1. Different Policies and Economic Coordination

Since the beginning of the 1980s, discussion regarding the roles of central banks and governments, as well as the relationship between monetary and fiscal authorities, started to gain more relevance. Although there is a separation of responsibilities – central banks are focused on inflation, whereas governments are concerned with cyclical conditions and the level of government indebtedness – both inflation and cyclical conditions depend on policy coordination, which means that monetary and fiscal policies depend on each other (Wyplosz, 1999).

However, this coordination may not always lead to the most desirable results, which consequently depends on the role assumed by each authority. Sargent and

Wallace (1981) argued that both authorities could be relevant in a “dominant” way. When monetary policy dominates fiscal policy, the monetary authority can permanently control inflation, as it is free to set the level for base money. However, if fiscal policy dominates monetary policy then the monetary authority loses some of its influence in controlling inflation, and since budget deficits cannot only be financed by the issue of new bonds, then the monetary authority has to print money and address the additional problem of inflation.

Aiyagari and Gertler (1985) introduced the distinction between Ricardian and non-Ricardian regimes, which characterises the behaviour of a government. In a non-Ricardian regime, primary budget balances are freely set by the government and prices are endogenously determined from the government’s budget constraints. Hence, the fiscal authority does not commit to completely financing debt through future taxes, thus leading to monetary financing. In a Ricardian regime, the monetary authority determines the stock of money and the price level, and the government has to achieve a certain degree of primary budget surplus in order for the budget constraint to be consistent with the repayment of the initial stock of debt and to ensure fiscal solvency.

According to Leeper (1991), fiscal policy could be “active” or “passive”, depending on the effect it will have when facing a government debt shock. An active authority discards the state of government debt and independently establishes a decision rule that depends on past, current and future variables. On the other hand, a passive authority’s decision rule depends on the current state of government debt once it has been constrained by the active authority’s actions and by the private optimisation.

Taylor (1993) further addressed the estimation of policy reaction function by initially proposing a monetary policy rule to control inflation for the U.S. in the early 1990s:

$$r = r^* + \beta(\pi - \pi^*) + \gamma(y - y^*). \quad (1)$$

In the so-called Taylor rule, equation (1), r represents the actual nominal short term interest rate, r^* the equilibrium nominal short term interest rate, π the actual rate of inflation, π^* the equilibrium rate of inflation, y the actual output and y^* the capacity output. As Ghatak and Moore (2011) state, whilst this rule describes the changes in the instruments that would accompany an increase in inflation or in real

GDP, its aim is to allow central banks to be successful in stabilising inflation and output gap. Later on, after the establishment of the EMU, many authors concluded that the Taylor rule is a useful tool for conducting monetary policy in the Union and that it provides a similar level of macroeconomic stabilisation, when compared with the optimal rule (Gerlach and Schnabel, 2000).

On the other hand, when dealing with fiscal issues, the key player is the government. Based on its intertemporal budget constraint and assuming the necessary and sufficient transversality condition, the government must determine a sustainable fiscal rule in the medium and long term:¹

$$\Delta b_t = d_{t-1} + r_t b_{t-1}, \quad (2)$$

where b_t is the public debt in year t , r_t is the real interest rate in t , $r_t b_{t-1}$ are the interest payments at the beginning of fiscal year $t-1$, and $d_{t-1} = g_{t-1} - \tau_{t-1} - s_{t-1}$ is the ratio of the government primary balance to GDP generated during $t-1$, in which g is the government expenditure net of interest, τ are the tax revenues net of transfers and s denotes the real revenues from seigniorage, assumed to be constant. In equation (2), and knowing that the primary balance can be a deficit or a surplus, the change in the public debt-to-GDP ratio must cover not only the primary balance to GDP ratio but also interest payments.

2.2. Previous Empirical Evidence

The reading of the available empirical literature shows that, several authors focussed either on the monetary or on the fiscal side, on the interactions between them, or on their impact on a country's economy.

Concerning the study of fiscal policy and its sustainability, the studies looked essentially at two main indicators: debt and primary balance. In Bohn (1998), the U.S. primary budget surplus turned out to be an increasing function and it responded positively to the debt-to-GDP ratio, which shows that U.S. fiscal policy satisfies an intertemporal budget constraint, in a Ricardian fashion. Galí and Perotti (2003) study how the Maastricht Treaty and the SGP changed the fiscal policy in EMU countries by

¹ See Afonso (2005) and Landolfo (2008) for more developments on the intertemporal budget constraint.

making them more procyclical, and they also detect a decrease in cyclically primary deficits when facing an increase in debt. On the other hand, Afonso (2005) uses causality tests between the primary balance and government debt ratios. The results of the various tests show that for all the sub-periods (pre- and post-Maastricht Treaty and SGP periods) between 1970 and 2003, the 15 EU governments raised the primary budget surpluses as a result of increases in the outstanding stock of government debt, and they appear to use primary budget surpluses to reduce the debt-to-GDP ratio. Therefore, we can acknowledge an evidence of Ricardian fiscal regime in these papers.

Moving to monetary policy, it can be observed that reaction functions are usually based on interest rates. Altavilla (2003) estimates several reaction functions² in order to assess how the European Central Bank (ECB) should control interest rates when facing a change in real output, inflation or the exchange rate. The conclusions are that: 1) central bank behaviour is better explained by adding a lagged interest rate and also future inflation movements; 2) the ECB should focus on simple monetary rules, as this increases the transparency and the credibility of the institution itself. Ruth (2007) develops a panel reaction function based on the Taylor rule for analysing the European monetary policy, namely, interest rate setting since 1999. Regarding the good's interest rate path, in the short-term, the author only finds deviation by the ECB in cases of area-wide inflation. Clausen and Hayo (2002) also find asymmetric monetary policy effects over the short- and medium-term for Germany, Italy and France.

Furthermore, besides just measuring an interest rate reaction function for 8 major EMU countries between 1980 and 1998, Huchet's (2003) main goal is to determine whether common monetary policy shocks induce asymmetric reactions on the real economic activity of each country. His conclusion is that "(...) a common change of monetary policy in all countries can lead to asymmetric reactions because these countries still have different national structures".

To study the interactions between monetary and fiscal policies, Leeper and Davig (2009) estimate Markov-switching policy rules for the United States. The paper's results highlight that the impacts of a fiscal stimulus cannot be understood without studying monetary and fiscal policies jointly, since they fluctuate between active and passive behaviour. A similar approach is provided by Afonso and Toffano (2013) who report for the UK "active" and "passive" fiscal regimes in a clearer cut way, while in

² Five different rules are estimated: three different specifications of the Taylor rule, an optimal feedback rule and a forward-looking rule.

Germany fiscal regimes have been overall less active, supporting more fiscal sustainability. For Italy, a more passive fiscal behaviour is uncovered in the run-up to EMU.

3. Empirical Specifications

3.1. Data and Variables

For the time period between 1970 and 2012 (43 years of annual observations), our dataset is based on 14 EU countries, where 11 belong to the Euro area³ – Austria (AT), Belgium (BE), Finland (FI), France (FR), Germany (DE), Greece (GR), Ireland (IE), Italy (IT), the Netherlands (NL), Portugal (PT) and Spain (ES) – and the other 3 are not part of the Euro area – Denmark (DK), Sweden (SE) and the United Kingdom (UK).

The variables used in the analysis are from several sources. From the European Commission AMECO database we gathered data regarding cyclically adjusted primary balance (*capb*), debt-to-GDP ratio (*debt*), nominal short-term interest rate (*interest*) and output gap between actual and potential gross domestic product (*output gap*); from the World Development Indicators (WDI) we obtained inflation (*inflation*); from the Financial Development and Structure dataset of the World Bank we collected M3 data, also referred to as liquid liabilities (*m3*). Table 1 presents the descriptive statistics for the full sample.

Table 1
Descriptive Statistics (full sample): 1970 - 2012

| | Mean | Std. Dev. | Minimum | Maximum | Observations |
|---|--------|-----------|-----------------------|-----------------------|--------------|
| <i>capb</i> (% of GDP) | 0.963 | 3.354 | -25.033 (IE, 2010) | 10.457 (DK, 1986) | 447 |
| <i>debt</i> (% of GDP) | 58.451 | 29.162 | 6.147 (FI, 1974) | 170.306 (GR, 2011) | 565 |
| <i>interest rate</i> (%) | 7.515 | 4.996 | 0.570 (PT, 2012) | 24.560 (GR, 1994) | 572 |
| <i>output gap</i> (% of potential GDP) | 0.089 | 2.350 | -11.915 (GR, 2012) | 7.709 (PT, 1972) | 581 |
| <i>inflation</i> (annual %) | 5.813 | 5.583 | -4.480 (IE, 2009) | 28.783 (PT, 1984) | 561 |
| <i>m3</i> (% of GDP) | 69.512 | 26.540 | 6.865 (IE, 1981) | 180.332 (UK, 2009) | 543 |

³ We do not consider Luxembourg due to the lack of data in some of the major variables.

To assess the impact of certain events on authorities' policies, we have created several dummy variables and included them in the regressions:

- *dmt*: dummy for the Maastricht Treaty, assuming a value of 1 in the years of and after the approval of the Treaty⁴, and 0 otherwise;
- *dsgp*: dummy for the adoption of the SGP framework, taking the value 1 for 1997 and subsequent years, and 0 elsewhere;
- *dez*: dummy for countries in the Euro area, being 1 for the year of and after they became Euro area countries⁵, and 0 for Denmark, Sweden and the United Kingdom, since they have not adopted the Euro.

Although we do not consider this as a dummy variable, we also want to study the effect a crisis can have on monetary and fiscal policies. Therefore, from the database⁶ of Reinhart and Rogoff (2009), we collected data regarding the total number of crises a country had in each year (*crisis*). In this dataset, the types of crises are banking, currency, inflation and stock market crises, which assume the character of a dummy variable in further tests (e.g. 1, if in year t country i had a banking crisis, and 0 otherwise).

3.2. Econometric Approach

We use a panel data approach, as it notably provides the possibility of obtaining a larger sample. The general linear model is the foundation of linear panel model estimation, which is why we can estimate the parameters using the Ordinary Least Squares (OLS) method. This method is associated with three basic assumptions: exogenous covariates, uncorrelated and homoscedastic errors. However, if they do not hold, OLS estimates are biased and/or inefficient. Plus, OLS bias could also be due to endogeneity whenever there are, for instance, omitted variables or measurement errors in the covariates. To address this problem we use two conventional regression based strategies: the fixed effects model and the two stage least squares (2SLS).

According to Wooldridge (2009), the fixed effects method allows for not only the estimation of panel data models with unobserved effects, as it is efficient when

⁴ The dates of the Maastricht referendum approval are different for each country: 1992 for Belgium, France, Greece, Ireland, Italy, the Netherlands, Portugal and Spain; 1993 for Denmark, Germany and the United Kingdom; 1994 for Austria, Finland and Sweden.

⁵ The date of entry is different among countries: 1999 for Austria, Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal and Spain; 2001 for Greece.

⁶ Available at: <http://www.reinhartandrogoff.com/data/browse-by-topic/>.

idiosyncratic errors are uncorrelated and homoscedastic, but also for the estimation of unbalanced panels, i.e., when the sample is missing years for some cross-sectional units.

Additionally, although the random effects method is more efficient when the unobserved effect is uncorrelated with all the explanatory variables, fixed effects is more useful to estimate *ceteris paribus* effects. However, it is possible to perform the Hausman test to verify which of both methods is the most appropriate, with random effects being the null-hypothesis. Therefore, rejecting the null-hypothesis proves evidence in favour of fixed effects. For our work, this same test indicates the use of random-effects for monetary policy, as well as for the reaction function of central banks, and the use of fixed-effects for fiscal policy and the reaction function of national governments.

The third method we use is the 2SLS, to allow for instrumental variable estimations. By enabling the use of instrumental variables – exogenous variables, totally uncorrelated with the error term and partially correlated with the explanatory variables – besides the existing explanatory variables, this method also estimates *ceteris paribus* effects. Therefore, it solves the endogeneity problem and leads to a consistent estimator when there are omitted variables. The advantage is that, if those instrumental variables are not poor, then they may very well satisfy the two properties mentioned above; 2SLS clearly becomes a more suitable method than OLS. In our 2SLS estimations, we generally used the lagged values of explanatory variables as instrumental variables.

OLS, OLS-Fixed Effects (OLS-FE) and 2SLS are the three panel data methods considered in the estimation of our regressions, and in all of them, we apply the White diagonal covariance matrix in order to assume residual heteroscedasticity.

In order to make a more complete analysis through studying the impact that monetary and fiscal authorities have on each country, we decided to develop a system of equations formed with the equations related to each country. The type of linear system of equations we use is the Seemingly Unrelated Regression (SUR) model, proposed by Zellner (1962). In this context, when the error terms are correlated in the different regression equations and when a diverse group of explanatory variables is included in those equations, the corresponding estimators become more efficient than in one single equation estimation.

4. Empirical Analysis

4.1. Policies of the Authorities

4.1.1. Monetary Policy

In our study, as well as in the majority of the literature who follows the Taylor rule, the instrument of monetary policy used is the interest rate. Regarding the explanatory variables, for instance, Huchet (2003) uses the lagged short-term interest rate, the inflation gap and the M3 growth gap compared to its 2% target and a 4.5% reference value, respectively, and also the output gap. Altavilla (2003) creates instrument rules which vary between inflation, output gap and interest rate, and their lagged values and an autoregressive term.

Therefore, we have set up our monetary policy regression for country i ($i=1,..., N$) at time t ($t=1,..., T$) in the following form:

$$interest_{it} = \beta_i + \delta interest_{it-1} + \phi inflation_{it-1} + \varphi outputgap_{it-1} + \lambda m3_{it-1} + u_{it}, \quad (3)$$

where $interest_{it}$ and $interest_{it-1}$ are the nominal short-term interest rate at times t and $t-1$, $inflation_{it-1}$ represents inflation in period $t-1$, $outputgap_{it-1}$ is the gap in $t-1$, $m3_{it-1}$ is the monetary aggregate M3 at time $t-1$, β_i represents the estimated individual effects for each country and u_{it} are the independent disturbances across countries

In Table 2 we present the estimated results for regression (3) and, as expected, the short-term interest rate is sensitive to inflation ($\phi > 0$), to the output gap ($\varphi > 0$) and to M3 ($\lambda < 0$). The estimation is conducted based on three methods, OLS, OLS-FE and 2SLS.⁷ The results display statistical significance in all variables, with the correct signs.

Apart from the larger impact of the lagged short-term interest rate, which softens interest rate fluctuations, inflation is the next most important variable in terms of influence on the instrument of monetary policy. The results show that a 1% increase in inflation leads to a raise of 0.165% in the nominal short-term interest rate, in order to reduce money supply, which will eventually lead to a decrease in inflation. Thus the stabilisation of the price level is in place. Clearly, sustainable economic growth is in the background, which is represented by the low positive effect that output gap has on

⁷ Both OLS and 2SLS estimations are based on cross-section random-effects, as the Hausman test indicates that they are the appropriate effects to consider.

interest rates. This also stresses the adversarial relationship mentioned earlier between sustainable economic growth and a stable level of prices. Looking at the results in more detail, a negative relation between interest rate and M3 is clear. Perhaps this could mean that if central banks want to increase M3, they should reduce interest rates in order to not jeopardise M3's reference value.

Table 2
Estimation of monetary policy with $interest_{it}$ as dependent variable: 1970-2012

| Method | OLS | OLS-FE | 2SLS |
|--------------------|----------------------|----------------------|----------------------|
| c | 1.190*** (0.343) | 1.315*** (0.416) | 1.226*** (0.384) |
| $interest_{it-1}$ | 0.789*** (0.029) | 0.784*** (0.029) | 0.790*** (0.034) |
| $inflation_{it-1}$ | 0.162*** (0.027) | 0.165*** (0.029) | 0.165*** (0.031) |
| $outputgap_{it-1}$ | 0.093** (0.037) | 0.090** (0.037) | 0.098*** (0.038) |
| $m3_{it-1}$ | -0.010*** (0.003) | -0.012*** (0.004) | -0.011*** (0.004) |
| Obs | 513 | 513 | 497 |
| R^2 | 0.879 | 0.880 | 0.879 |
| Adj. R^2 | 0.878 | 0.876 | 0.878 |
| D-W stat | 2.055 | 2.057 | 2.067 |
| Hausman prob | 0.9232 | - | 0.9567 |

Notes: *, ** and *** represent statistical significance at 10%, 5% and 1% levels, respectively. The robust standard errors are in brackets. *Obs* represents the total number of observations. *D-W stat* is the Durbin-Watson statistic. *Hausman prob* refers to the probability reached in the Hausman test.

Applying the SUR model in regression (3), formed by a system of 14 equations related to each country individually, we were able to estimate their monetary policies and thus carry out a more careful analysis through the results displayed in Table 3.

Denmark, Finland, France, Spain and Sweden are the only countries that follow the usual pattern: inflation is statistically significant and there are expected signs for all coefficients. Some other countries either do not display the expected sign or inflation seems to be less of a priority goal. For instance, whenever inflation is not significant, cyclical conditions or M3 levels assume a more relevant role: in Austria and in the United Kingdom, the major responses being to the levels of output (if they approach the potential level) and to the values established for M3, since both significantly influence short-term interest rates. On the other hand, in Ireland and in the Netherlands interest rates are only affected by M3 and output gap levels, respectively.

Belgium and Germany are an exception to the rule because apparently, nominal short-term interest rate is only influenced by its auto-regressive term.

Table 3SUR estimation of monetary policy with $interest_{it}$ as dependent variable: 1970-2012

| Countries | c | $interest_{it-1}$ | $inflation_{it-1}$ | $outputgap_{it-1}$ | $m3_{it-1}$ | Obs | R^2 |
|----------------|---------------------|---------------------|---------------------|----------------------|----------------------|-----|-------|
| Austria | 4.988*** (1.518) | 0.582*** (0.078) | -0.083 (0.107) | 0.248** (0.109) | -0.033*** (0.016) | 40 | 0.674 |
| Belgium | 2.989*** (1.146) | 0.600*** (0.078) | 0.116 (0.074) | -5.71E-05 (0.106) | -0.016 (0.011) | 40 | 0.756 |
| Denmark | 2.163 (2.070) | 0.689*** (0.083) | 0.188** (0.091) | 0.117 (0.106) | -0.016 (0.030) | 42 | 0.827 |
| Finland | 4.280*** (1.577) | 0.684*** (0.056) | 0.118* (0.062) | 0.083 (0.059) | -0.052* (0.027) | 42 | 0.865 |
| France | 3.216*** (1.060) | 0.570*** (0.071) | 0.175*** (0.064) | 0.071 (0.082) | -0.020 (0.015) | 42 | 0.766 |
| Germany | 2.582 (1.608) | 0.723*** (0.253) | -0.356 (0.316) | 0.124 (0.147) | -0.012 (0.012) | 20 | 0.683 |
| Greece | -2.899 (2.728) | 0.818*** (0.089) | 0.245*** (0.071) | 0.177 (0.151) | 0.029 (0.029) | 32 | 0.930 |
| Ireland | 4.869*** (1.039) | 0.598*** (0.076) | 0.011 (0.051) | 0.080 (0.075) | -0.035*** (0.010) | 41 | 0.852 |
| Italy | 3.482*** (1.240) | 0.575*** (0.068) | 0.268*** (0.067) | -0.061 (0.137) | -0.026 (0.019) | 42 | 0.841 |
| Netherlands | 3.398*** (0.773) | 0.462*** (0.073) | 0.004 (0.069) | 0.205** (0.084) | -0.011 (0.007) | 42 | 0.598 |
| Portugal | 0.366 (1.092) | 0.764*** (0.047) | 0.164*** (0.035) | 0.001 (0.063) | 0.001 (0.012) | 42 | 0.943 |
| Spain | 2.983* (1.525) | 0.616*** (0.090) | 0.271*** (0.075) | 0.034 (0.122) | -0.018 (0.012) | 35 | 0.896 |
| Sweden | 2.116 (1.500) | 0.650*** (0.112) | 0.273* (0.143) | 0.072 (0.135) | -0.015 (0.025) | 30 | 0.851 |
| United Kingdom | 5.214*** (1.239) | 0.421*** (0.144) | 0.265 (0.219) | 0.391*** (0.391) | -0.024*** (0.008) | 23 | 0.861 |

Notes: *, ** and *** represent statistical significance at 10%, 5% and 1% levels, respectively. The robust standard errors are in brackets. *Obs* represents the total number of observations. SUR linear estimation after one-step weighting matrix; total system with 513 observations.

4.1.2. Fiscal Policy

The assessment for fiscal policy is usually based on the primary budget balance, in order for governments to achieve a certain level of primary surplus to diminish the outstanding stock of public debt. Therefore, the primary balance is commonly used as the dependent variable in the regressions for fiscal rules (or fiscal reaction functions). However, the explanatory variables included in the regressions also differ from author to author. Galí and Perotti (2003) use expected output gap, debt at the time of budget decision (relative to potential output) and the last year cyclically unadjusted total budget deficit (as a percentage of GDP). In addition, Bohn (1998) includes the ratio of debt to aggregate income, the level of temporary government spending and a business cycle indicator.

The fiscal policy regression we follow is notably presented by Afonso (2005), and is a simple linear dynamic model:

$$capb_{it} = \beta_i + \alpha capb_{it-1} + \sigma debt_{it-1} + u_{it}, \quad (4)$$

where the cyclically-adjusted primary balance of country i at year t ($capb_{it}$) depends on its previous observation ($capb_{it-1}$) and on the debt-to-GDP ratio of year $t-1$ ($debt_{it-1}$).

Bearing this in mind, the hypothesis we want to test is $\sigma > 0$, meaning that the expected result is a positive reaction of the primary balance to changes in government debt. Table 4 reports the outcomes for fiscal policy reaction function (4), and as the estimated coefficient for debt is statistically significant we cannot reject this hypothesis.

Table 4
Estimation of fiscal policy with $capb_{it}$ as dependent variable: 1970-2012

| Method | OLS | OLS-FE | 2SLS |
|---------------|----------------------|----------------------|----------------------|
| c | -0.491*** (0.226) | -1.448*** (0.312) | -1.636*** (0.354) |
| $capb_{it-1}$ | 0.822*** (0.074) | 0.741*** (0.089) | 0.729*** (0.072) |
| $debt_{it-1}$ | 0.011*** (0.003) | 0.027*** (0.005) | 0.030*** (0.005) |
| Obs | 428 | 428 | 414 |
| R^2 | 0.678 | 0.703 | 0.701 |
| Adj. R^2 | 0.677 | 0.693 | 0.690 |
| D-W stat | 2.036 | 2.012 | 2.028 |
| Hausman prob | 0.0000 | - | 0.000 |

Notes: *, ** and *** represent statistical significance at 10%, 5% and 1% levels, respectively. The robust standard errors are in brackets. *Obs* represents the total number of observations. *D-W stat* is the Durbin-Watson statistic. *Hausman prob* refers to the probability reached in the Hausman test.

In the end, the governments of these 14 EU countries raise primary budget surplus when facing increases in the outstanding stock of government debt. This stabilising behaviour by governments, especially in adjusting the intertemporal budget constraint, translates into a Ricardian fiscal regime. Bohn (1998), Favero (2002) and Afonso (2005) also reached the same conclusion in their studies. In the three methods, all the estimated coefficients are statistically significant. Nevertheless, it is when we use the 2SLS method, with cross-section fixed effects, that the primary balance reacts more positively to government debt, by rising 0.3% when the debt ratio increases by 10%.

Subsequently, we have estimated the fiscal policy reaction functions in each country separately, using the SUR model. Table 5 shows the results.

Table 5
SUR estimation of fiscal policy with $capb_{it}$ as dependent variable: 1970-2012

| Countries | c | $capb_{it-1}$ | $debt_{it-1}$ | Obs | R^2 |
|----------------|----------------------|---------------------|---------------------|-----|-------|
| Austria | -1.604** (0.753) | 0.228* (0.136) | 0.033** (0.013) | 36 | 0.314 |
| Belgium | -2.893*** (0.861) | 0.716*** (0.077) | 0.034*** (0.009) | 42 | 0.827 |
| Denmark | -0.367 (0.464) | 0.774*** (0.076) | 0.025*** (0.009) | 41 | 0.760 |
| Finland | 1.440* (0.857) | 0.715*** (0.105) | -0.009 (0.016) | 35 | 0.610 |
| France | 0.098 (0.346) | 0.572*** (0.125) | -0.008 (0.008) | 34 | 0.507 |
| Germany | -4.155** (1.758) | 0.053 (0.156) | 0.074** (0.029) | 21 | 0.170 |
| Greece | -2.744 (1.867) | 0.671*** (0.108) | 0.027 (0.018) | 24 | 0.588 |
| Ireland | -2.488 (1.769) | 0.624*** (0.114) | 0.040* (0.023) | 27 | 0.550 |
| Italy | -5.683*** (1.716) | 0.636*** (0.103) | 0.059*** (0.017) | 32 | 0.865 |
| Netherlands | -0.786 (0.779) | 0.619*** (0.097) | 0.021 (0.013) | 37 | 0.540 |
| Portugal | -2.446** (0.998) | 0.510*** (0.119) | 0.035** (0.017) | 35 | 0.294 |
| Spain | -4.173** (1.877) | 0.994*** (0.119) | 0.075** (0.034) | 17 | 0.766 |
| Sweden | -0.369 (1.118) | 0.572*** (0.100) | 0.030* (0.018) | 19 | 0.586 |
| United Kingdom | -2.764*** (0.975) | 0.934*** (0.084) | 0.059*** (0.021) | 26 | 0.742 |

Notes: *, ** and *** represent statistical significance at 10%, 5% and 1% levels, respectively. The robust standard errors are in brackets. *Obs* represents the total number of observations. SUR linear estimation after one-step weighting matrix; total system with 428 observations.

Austria, Belgium, Denmark, Germany, Ireland, Italy, Portugal, Spain, Sweden and the United Kingdom have governments that follow Ricardian fiscal regimes: debt is statistically significant and whenever it increases, primary budget surplus is raised in order to stabilise the financial situation. This pattern is also pursued by Greece and the Netherlands, although debt does not show up as being significant.

Finland and France represent the exceptions to this fiscal behaviour, as the debt estimated coefficient is negative but also not statistically significant.

4.2. Interactions between Monetary and Fiscal Authorities

Besides estimating the policies of each authority, we have also decided to include fiscal (monetary) variables in the monetary (fiscal) regression, to highlight, in a different way, the real concerns of national governments and central banks, along the lines of Wyplosz (1999). Hence we will be able to identify the interactions between monetary policy and fiscal policy – which is one of the goals of our study.

4.2.1. Reaction Function of the Central Banks

Wyplosz (1999) presents a reaction function for central banks, based on several explanatory variables: interest rate lagged, inflation lagged, output gap lagged, money growth lagged, relative unit labour costs, US interest rate, primary surplus lagged (% of GDP), change in primary surplus lagged (% of GDP) and current account (% of GDP).

Our regression is simpler, adding only to equation (3) the most important fiscal variable, which is the change in cyclically-adjusted primary balance of country i at time $t-1$ ($\Delta capb_{it-1}$):

$$interest_{it} = \beta_i + \delta interest_{it-1} + \phi inflation_{it-1} + \varphi outputgap_{it-1} + \lambda m3_{it-1} + \theta \Delta capb_{it-1} + u_{it}. \quad (5)$$

The estimation for central banks' reaction function is presented in Table 6. Whilst estimating regression (5), the expected results are $\phi, \varphi > 0$ and $\lambda, \theta < 0$, and as the three methods meet these hypotheses, we continue to focus on the 2SLS estimation.⁸

The two main conclusions from this estimation are: 1) central banks are concerned with price stability and economic growth, and with an intermediate goal regarding monetary aggregates; and, on the other hand, 2) central banks do not appear to react much to a country's fiscal stance.

Nevertheless, the results exhibit statistical significance for the estimated coefficients of inflation, output gap and M3: whenever there is a 1% increase in the previous year's rate of inflation or output gap, central banks raise the short-term interest rate by 0.183% and 0.117%, respectively; and an increase of 1% of M3 implies a decrease of 0.012% of interest rate to meet the goal. Also, the estimated coefficient for the change in the primary balance is not significant, which means central banks do not respond in this way to fiscal policy.

⁸ With cross-section random effects, due to Hausman test's proof.

Table 6

Estimation of central banks' reaction function with $interest_{it}$ as dependent variable:
1970-2012

| Method | OLS | OLS-FE | 2SLS |
|----------------------|----------------------|----------------------|----------------------|
| c | 1.183*** (0.366) | 1.302*** (0.453) | 1.266*** (0.388) |
| $interest_{it-1}$ | 0.785*** (0.037) | 0.781*** (0.037) | 0.775*** (0.039) |
| $inflation_{it-1}$ | 0.178*** (0.039) | 0.184*** (0.042) | 0.183*** (0.043) |
| $outputgap_{it-1}$ | 0.117*** (0.038) | 0.116*** (0.039) | 0.117*** (0.039) |
| $m3_{it-1}$ | -0.011*** (0.004) | -0.013*** (0.005) | -0.012*** (0.004) |
| $\Delta capb_{it-1}$ | -0.013 (0.035) | -0.012 (0.035) | -0.012 (0.034) |
| Obs | 413 | 413 | 409 |
| R^2 | 0.892 | 0.893 | 0.893 |
| Adj. R^2 | 0.891 | 0.888 | 0.888 |
| D-W stat | 1.947 | 1.964 | 1.950 |
| Hausman prob | 0.9469 | - | 0.9785 |

Notes: *, ** and *** represent statistical significance at 10%, 5% and 1% levels, respectively. The robust standard errors are in brackets. *Obs* represents the total number of observations. *D-W stat* is the Durbin-Watson statistic. *Hausman prob* refers to the probability reached in the Hausman test.

Table 7 displays the results for a SUR estimation regarding to the central bank's reaction function of each country. According to Wyplosz (1999), a positive sign for the estimated primary balance coefficient implies a complementary relation between both authorities. However, in all countries, apart from Belgium and Spain, the cyclically-adjusted primary balance is not statistically significant, which is what we already expected, given the panel results: based on the lack of evidence concerning central banks' response to fiscal policy.

Comparing these results to the benchmark SUR estimation of monetary policy, in most of these countries, their respective interest rates are influenced by the same, or additional factors, such as Austria, Finland, Greece, Italy, Portugal and the United Kingdom.

In the case of Spain, the primary balance is statistically significant and it also presents different signs for the estimated coefficients of inflation and M3, and its interest rate is affected by all monetary variables (when before, it was just positively influenced by inflation).

Table 7
SUR estimation of central banks' reaction function with $interest_{it}$ as dependent
variable: 1970-2012

| Countries | c | $interest_{it-1}$ | $inflation_{it-1}$ | $outputgap_{it-1}$ | $m3_{it-1}$ | $\Delta capb_{it-1}$ | Obs | R^2 |
|----------------|---------------------|---------------------|----------------------|---------------------|----------------------|----------------------|-----|-------|
| Austria | 5.860*** (2.130) | 0.633*** (0.110) | -0.104 (0.176) | 0.308** (0.132) | -0.045** (0.022) | 0.118 (0.113) | 33 | 0.744 |
| Belgium | 3.454*** (1.275) | 0.646*** (0.087) | 0.122 (0.079) | -0.030 (0.115) | -0.027** (0.012) | -0.276*** (0.093) | 39 | 0.815 |
| Denmark | 2.509 (2.493) | 0.785*** (0.094) | 0.110 (0.120) | 0.181 (0.124) | -0.028 (0.036) | -0.047 (0.164) | 41 | 0.785 |
| Finland | 6.236*** (1.802) | 0.739*** (0.064) | 0.046 (0.086) | 0.141** (0.063) | -0.091*** (0.031) | -0.166 (0.104) | 37 | 0.664 |
| France | 2.896*** (1.107) | 0.617*** (0.076) | 0.004*** (0.075) | 0.152* (0.092) | -0.028* (0.015) | 0.081 (0.150) | 34 | 0.546 |
| Germany | 1.844 (1.309) | 0.824*** (0.199) | -0.541** (0.253) | 0.117 (0.118) | -0.005 (0.010) | 0.034 (0.049) | 20 | 0.286 |
| Greece | 0.430 (2.350) | 0.605*** (0.095) | 0.615*** (0.106) | -0.073 (0.145) | -0.018 (0.026) | -0.186 (0.126) | 24 | 0.698 |
| Ireland | 2.366 (1.904) | 0.705*** (0.122) | 0.041 (0.137) | 0.121 (0.092) | -0.015 (0.017) | -0.023 (0.042) | 27 | 0.615 |
| Italy | 1.302 (1.322) | 0.729*** (0.072) | 0.225** (0.286) | 0.158 (0.116) | -0.011 (0.019) | -0.134 (0.108) | 32 | 0.894 |
| Netherlands | 3.175*** (1.048) | 0.532*** (0.090) | 0.050 (0.088) | 0.186 (0.117) | -0.013 (0.009) | 0.182 (0.118) | 37 | 0.606 |
| Portugal | 1.445 (1.629) | 0.619*** (0.064) | 0.300*** (0.050) | 0.348*** (0.092) | -0.008 (0.016) | 0.060 (0.081) | 35 | 0.382 |
| Spain | 0.681 (0.833) | 0.740*** (0.102) | -0.507*** (0.161) | 0.356*** (0.079) | 0.013** (0.006) | 0.374*** (0.082) | 17 | 0.776 |
| Sweden | -0.236 (1.567) | 0.908*** (0.200) | -0.331 (0.322) | 0.161 (0.157) | 0.020 (0.023) | -0.103 (0.171) | 19 | 0.662 |
| United Kingdom | 4.694*** (1.321) | 0.478*** (0.164) | 0.180 (0.235) | 0.371** (0.161) | -0.021** (0.009) | 0.023 (0.113) | 23 | 0.712 |

Notes: *, ** and *** represent statistical significance at 10%, 5% and 1% levels, respectively. The robust standard errors are in brackets. *Obs* represents the total number of observations. SUR linear estimation after one-step weighting matrix; total system with 413 observations.

4.2.2. Reaction Function of the National Governments

For the fiscal reaction function, we follow the same approach as Wyplosz (1999), with regards to the choice of explanatory variables, but without relative unit labour costs. Still, we have decided to introduce the first-differences of the short-term interest rate, in order to attain most of the expected results. Hence, the regression is presented as follow:

$$capb_{it} = \beta_i + \alpha capb_{it-1} + \delta \Delta interest_{it-1} + \phi \Delta inflation_{it-1} + \varphi outputgap_{it-1} + \sigma \Delta debt_{it-1} + u_{it} \quad (6)$$

The estimated results are summarised in Table 8. Naturally, primary balance stills reacts positively to government debt ($\sigma > 0$), and its impact is larger than when we consider the simple fiscal policy reaction function (4). Output gap is also statistically

significant and the result is the expected one ($\varphi > 0$). In fact, governments are concerned with cyclically conditions: whenever the output gap deteriorates by 1%, the primary balance improves by 0.245%.

Table 8
Estimation of national governments' reaction function with $capb_{it}$ as dependent variable: 1970-2012

| Method | OLS | OLS-FE | 2SLS |
|--------------------------|---------------------|----------------------|----------------------|
| c | -0.624 (0.393) | -3.236*** (0.708) | -3.280*** (0.606) |
| $capb_{it-1}$ | 0.819*** (0.078) | 0.707*** (0.084) | 0.702*** (0.068) |
| $\Delta interest_{it-1}$ | -0.012 (0.053) | -0.029 (0.051) | -0.143 (0.143) |
| $inflation_{it-1}$ | 0.014 (0.035) | 0.123*** (0.046) | 0.134*** (0.039) |
| $outputgap_{it-1}$ | 0.062 (0.050) | 0.199*** (0.060) | 0.245** (0.123) |
| $debt_{it-1}$ | 0.012*** (0.003) | 0.047*** (0.008) | 0.047*** (0.007) |
| Obs | 423 | 423 | 410 |
| R^2 | 0.680 | 0.725 | 0.723 |
| Adj. R^2 | 0.676 | 0.713 | 0.711 |
| D-W stat | 2.029 | 2.064 | 2.149 |
| Hausman prob | 0.000 | - | 0.000 |

Notes: *, ** and *** represent statistical significance at 10%, 5% and 1% levels, respectively. The robust standard errors are in brackets. *D-W stat* is the Durbin-Watson statistic. *Hausman prob* refers to the probability reached in the Hausman test.

The significance of inflation is also interesting. Therefore, the fiscal authority must achieve the necessary levels of primary budgetary surpluses, to ensure that its budget constraint is consistent with the price level determined by the monetary authority. The results precisely show a reduction of 0.134% in the cyclically adjusted budget deficit after a 1% increase in inflation. This is the basic process that occurs in a Ricardian fiscal regime.

In all of the methods used to estimate the regression, the interest rate variation is the only variable that is not statistically significant. Yet, the displayed signal is the expected one ($\delta < 0$), indicating again that there is a substitution relationship between both authorities: whereby increases in interest rate lead to a more relaxed fiscal policy, as mentioned by Wyplosz (1999).

Once again, we have estimated a SUR model to study how national fiscal reaction functions behave in each country separately. Naturally, the expected result is a statistically significance coefficient for the debt ratio with a positive effect on the

measure of fiscal stance. Excluding France and Spain, Table 9 shows that result for all countries, which shows that their governments follow a Ricardian fiscal regime.

Table 9
SUR estimation of national governments' reaction function with $capb_{it}$ as dependent variable: 1970-2012

| Countries | c | $capb_{it-1}$ | $\Delta interest_{it-1}$ | $inflation_{it-1}$ | $outputgap_{it-1}$ | $debt_{it-1}$ | Obs | R^2 |
|----------------|-----------------------|---------------------|--------------------------|---------------------|---------------------|---------------------|-----|-------|
| Austria | -2.987** (1.227) | 0.101 (0.119) | 0.169* (0.092) | 0.040 (0.120) | 0.430*** (0.115) | 0.056*** (0.017) | 36 | 0.504 |
| Belgium | -3.368*** (1.244) | 0.663*** (0.094) | -0.116 (0.128) | 0.023 (0.092) | 0.203 (0.174) | 0.039*** (0.011) | 41 | 0.828 |
| Denmark | -0.909 (0.732) | 0.736*** (0.081) | -0.089 (0.094) | 0.029 (0.058) | 0.172* (0.090) | 0.035*** (0.011) | 41 | 0.785 |
| Finland | -1.822 (1.224) | 0.667*** (0.105) | -0.037 (0.150) | 0.313*** (0.088) | 0.180* (0.094) | 0.054** (0.023) | 37 | 0.664 |
| France | -0.412 (0.719) | 0.652*** (0.127) | -0.036 (0.104) | 0.045 (0.057) | -0.096 (0.090) | -0.001 (0.0113) | 34 | 0.546 |
| Germany | -5.945* (3.327) | -0.078 (0.153) | 0.574 (0.400) | 0.415 (0.370) | -0.102 (0.325) | 0.094** (0.046) | 20 | 0.286 |
| Greece | -13.606*** (4.013) | 0.667*** (0.094) | -0.371** (0.145) | 0.319*** (0.089) | 0.320 (0.250) | 0.107*** (0.034) | 24 | 0.698 |
| Ireland | -7.022*** (2.495) | 0.421*** (0.131) | 0.102 (0.541) | 1.133*** (0.417) | 0.246 (0.390) | 0.061** (0.029) | 27 | 0.615 |
| Italy | -16.433*** (3.776) | 0.454*** (0.105) | -0.044 (0.144) | 0.286*** (0.099) | 0.104 (0.158) | 0.151*** (0.032) | 32 | 0.894 |
| Netherlands | -2.855** (1.133) | 0.691*** (0.096) | 0.270** (0.118) | 0.238** (0.097) | -0.251** (0.126) | 0.043*** (0.016) | 37 | 0.606 |
| Portugal | -5.943*** (1.798) | 0.473*** (0.111) | -0.223 (0.156) | 0.126** (0.055) | 0.370*** (0.126) | 0.073*** (0.024) | 35 | 0.382 |
| Spain | -4.187* (2.458) | 0.984*** (0.203) | -0.399 (0.402) | 0.399 (0.488) | -0.116 (0.265) | 0.050 (0.039) | 17 | 0.776 |
| Sweden | 0.251 (1.314) | 0.330** (0.136) | 0.173 (0.199) | -0.452** (0.210) | 0.168 (0.164) | 0.047** (0.019) | 19 | 0.662 |
| United Kingdom | -5.270*** (1.467) | 0.810*** (0.098) | -0.289 (0.237) | -0.002 (0.146) | 0.446* (0.253) | 0.103*** (0.028) | 23 | 0.712 |

Notes: *, ** and *** represent statistical significance at 10%, 5% and 1% levels, respectively. The robust standard errors are in brackets. Obs represents the total number of observations. SUR linear estimation after one-step weighting matrix; total system with 423 observations.

Regarding monetary variables, firstly, none of these variables have statistical significance in Belgium and Germany. Secondly, in some countries, only one monetary variable comes up as being relevant to determine the necessary primary budget surplus, such as in the cases of Denmark, Ireland, Italy, Sweden and the United Kingdom. In Austria, Finland, Greece and Portugal, the primary balance suffers the impact of two monetary variables, with the Netherlands being the only country where fiscal policy is determined by considering changes in short-term interest rate and levels of output gap and inflation. To sum up, fiscal developments at country level are more sensitive to the price level and to cyclical conditions.

Comparing this test to the SUR estimation of central banks' reaction function, the results lead us to conclude that the relationship between a national government and its central bank does not change in both estimations when the interest rate is statistically significant. For example, the short-term interest rates from Austria and the Netherlands positively influence primary balance, which suggests a complementary relationship; whilst the negative sign for Greece's interest rate suggests a substitution relationship. However, if interest rate is not significant, then the relationship between both authorities could change in the SUR estimations of central banks and national governments' reaction functions. In the cases of Belgium, Denmark, Finland, Germany and Italy, the relationship does not alter, which is contrary to France, Ireland, Portugal, Spain, Sweden and the United Kingdom.

4.3. Institutional Variables

In this section we once again estimate regressions (3) and (4) with the goal of studying the effects that three institutional events – the Maastricht Treaty, the SGP and the introduction of the Euro – had on the monetary and fiscal policies of our country sample. All of these three variables are included in the previous regressions as dummy variables. Another event is the combination of banking, currency, inflation crises and even stock market crashes,⁹ which represent the total number of crises each country faced through time.

Table 10 and Table 11 report the estimation results of the effects of these events on monetary policy and fiscal policy, respectively, using the 2SLS method¹⁰, with random and fixed effects for the estimations of monetary and fiscal policies, respectively, as induced by the Hausman test.

Regarding monetary policy, the Maastricht Treaty, besides the similar, but smaller effect of the SGP and of the introduction of the Euro, is related to a sharp decline in short-term interest rate of 1.563%. This probably occurred because it was the initial step towards creating a more united Europe, and thus represented the so-called convergence process between all the EU members. Within these three events, the goals of central banks remain statistically significant, being namely the impact that inflation has on monetary policy increased along time. Nevertheless, M3 turned out to gain more

⁹ The regression of the effect each crisis has individually on both policies is estimated through OLS, OLS-FE and 2SLS methods, and it is present in the Appendix – Additional Estimation Results, Table 16.

¹⁰ The same estimations are done with OLS and OLS-FE, and they can be found in Appendix – Additional Estimation Results, Tables 12 to 15.

relevance with the introduction of the Euro, as concerns with monetary aggregates reference values became secondary goals for central banks.

Table 10
2SLS estimation of institutional variables' effect on monetary policy with $interest_{it}$ as dependent variable: 1970-2012

| Test | (1) | (2) | (3) | (4) | (5) |
|--------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| c | 2.130*** (0.460) | 2.016*** (0.473) | 1.430*** (0.403) | 1.161*** (0.389) | 1.309*** (0.408) |
| $interest_{it-1}$ | 0.758*** (0.035) | 0.703*** (0.045) | 0.752*** (0.040) | 0.791*** (0.033) | 0.762*** (0.039) |
| $inflation_{it-1}$ | 0.108*** (0.031) | 0.170*** (0.031) | 0.175*** (0.032) | 0.185*** (0.032) | 0.192*** (0.032) |
| $outputgap_{it-1}$ | 0.112*** (0.038) | 0.132*** (0.040) | 0.115*** (0.039) | 0.101*** (0.038) | 0.114*** (0.040) |
| $m3_{it-1}$ | -0.003 (0.004) | -0.005 (0.004) | -0.008** (0.004) | -0.007* (0.004) | -0.004 (0.004) |
| dmt_{it} | -1.563*** (0.290) | - | - | - | - |
| $dsgp_{it}$ | - | -1.306*** (0.310) | - | - | - |
| dez_{it} | - | - | -0.645*** (0.222) | - | -0.483** (0.222) |
| $crisis_{it-1}$ | - | - | - | -0.619*** (0.152) | -0.589*** (0.153) |
| Obs | 497 | 497 | 497 | 483 | 483 |
| R^2 | 0.887 | 0.886 | 0.882 | 0.880 | 0.882 |
| Adj. R^2 | 0.886 | 0.881 | 0.881 | 0.879 | 0.880 |
| D-W stat | 2.117 | 1.992 | 2.046 | 2.008 | 1.989 |
| Hausman prob | 0.1719 | 0.4592 | 0.9548 | 0.9366 | 0.8827 |

Notes: *, ** and *** represent statistical significance at 10%, 5% and 1% levels, respectively. The robust standard errors are in brackets. *Obs* represents the total number of observations. *D-W stat* is the Durbin-Watson statistic. *Hausman prob* refers to the probability reached in the Hausman test.

The implementation of the Euro as a common currency was the major event to have a negative impact on fiscal policy: cyclically-adjusted primary balance decreased by 0.817% (Table 11). Previously, there had already been monetary union and free mobility of capital, which allowed for banks from the countries of the south of Europe to ask for loans from the banks of the north in the interbank money market – interest rates charged for credit to companies and households was extremely high in these southern countries and much lower in the northern European ones. However, this did not occur on account of exchange risk. When the Euro emerged, this risk disappeared, and southern European countries started to request more loans from the northern countries, which led to a further decrease in interest rates and to an increase in public debt, especially in those countries that took out the loans. Therefore, it became more

than necessary to achieve a higher primary balance to meet this increase in outstanding government debt. These results are in line with Baskaran (2009), who finds that the Maastricht treaty's provisions did not have the expected positive effect on economic growth and fiscal outcomes, especially after the introduction of the Euro. Galí and Perotti (2003) also mention that fiscal policy did not become less countercyclical after the Maastricht treaty.

Table 11
2SLS estimation of institutional variables' effect on fiscal policy with $capb_{it}$ as
dependent variable: 1970-2012

| Test | (1) | (2) | (3) | (4) | (5) |
|-----------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| c | -1.609*** (0.346) | -1.563*** (0.346) | -1.585*** (0.347) | -1.422*** (0.361) | -1.391*** (0.365) |
| $capb_{it-1}$ | 0.744*** (0.075) | 0.744*** (0.075) | 0.740*** (0.074) | 0.718*** (0.089) | 0.737*** (0.093) |
| $debt_{it-1}$ | 0.036*** (0.006) | 0.035*** (0.005) | 0.034*** (0.005) | 0.030*** (0.006) | 0.033*** (0.006) |
| dmt_{it} | -0.610** (0.237) | - | - | - | - |
| $dsgp_{it}$ | - | -0.681*** (0.223) | - | - | - |
| dez_{it} | - | - | -0.817*** (0.237) | - | -0.757*** (0.241) |
| $crisis_{it-1}$ | - | - | - | -0.321** (0.153) | -0.262* (0.144) |
| Obs | 414 | 414 | 414 | 400 | 400 |
| R^2 | 0.704 | 0.705 | 0.709 | 0.704 | 0.711 |
| Adj. R^2 | 0.692 | 0.694 | 0.697 | 0.691 | 0.698 |
| D-W stat. | 2.075 | 2.077 | 2.105 | 1.968 | 2.048 |
| Hausman prob | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

Notes: *, ** and *** represent statistical significance at 10%, 5% and 1% levels, respectively. The robust standard errors are in brackets. *Obs* represents the total number of observations. *D-W stat* is the Durbin-Watson statistic. *Hausman prob* refers to the probability reached in the Hausman test.

While introducing $crisis_{it-1}$ as a variable, the estimated results exhibit that the total crises of each country had a negative impact along the period of time considered for both policies. Furthermore, when we carried out the tests to determine which crises influenced most these policies, we concluded that banking, inflation and stock market crises affect fiscal policy, whilst only the latter two affect monetary policy.

The final test we carried out shows that countries belonging to the Euro area suffer less during periods of crisis. In terms of monetary policy, the effect ranged from -0.619% to -0.589%, and in the case of fiscal policy, the effect is more significant, ranging from -0.321% to -0.262%. According to Cukierman (2013), the Euro area has some particular problems when facing a financial crisis, and, for instance, bailouts have

to be negotiated by the governments of each country, and, without any type of support, some countries from the Euro area could become insolvent. Likewise, the ECB is able to establish stability within the monetary union, as well as being able to respect its foundations.

5. Conclusions

Over the last decades the study of the interactions between monetary policy and fiscal policy has gained more relevance, especially after the creation of the EMU, which led to a more distant, less cooperative, relationship. Thus, our study focused on 14 EU countries, and on the well-known major goals of both policies, which are dependent on certain economic variables, as well as trying to determine what type of interactions have been established.

With regards to monetary policy, inflation is the variable which has influenced most the monetary instrument, in addition to output gap and M3, which is no surprise, as price stability is the primary goal of central banks, as proved by the results from their reaction function regression. In fiscal terms, primary balance followed the expected behaviour, by reacting positively to increases in government debt, and the reaction function for national governments evidenced a major concern for levels of public debt, and it did the same, although less so, for the levels of inflation and output gap. All of these conclusions can be related to Ricardian fiscal regimes.

Certain institutional events that affected the EU, namely the Maastricht Treaty, the SGP and the implementation of the Euro, all have a significant effect on the policies followed by policy makers. However, the impact that they have on each policy differs. The Maastricht Treaty was the most significant event for monetary policy, as it was the first step towards a more united Europe; the introduction of the Euro had the greatest effect on fiscal policy, which was a negative one, leading to a decrease in primary balances. In addition, when faced by various crises over the entire period, these events all had a negative impact on both policies.

In summary, the consensus assignment where monetary authority controls inflation and fiscal policy controls government debt, became clear. However, when governments attain high levels of public debt or budget deficits, then the central bank could assume a somewhat more dominant position, in order to tackle the fiscal problem. Nevertheless, our results point to the lack of evidence concerning central banks' response to fiscal policy.

In the country individual analysis, although the majority of the countries belong to the EMU, i.e. monetary policy is the same, fiscal policy is completely different, which thus leads to a variety of interactions across countries, as well as some other results.

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Appendix

Table 12

OLS estimation of institutional variables' effect on monetary policy with $interest_{it}$ as dependent variable: 1970-2012

| Test | (1) | (2) | (3) | (4) | (5) |
|--------------------|---------------------|----------------------|----------------------|----------------------|----------------------|
| c | 1.886*** (0.399) | 1.779*** (0.397) | 1.393*** (0.354) | 1.065*** (0.344) | 1.235*** (0.356) |
| $interest_{it-1}$ | 0.757*** (0.031) | 0.725*** (0.037) | 0.750*** (0.034) | 0.788*** (0.029) | 0.756*** (0.033) |
| $inflation_{it-1}$ | 0.124*** (0.027) | 0.158*** (0.027) | 0.168*** (0.028) | 0.190*** (0.027) | 0.193*** (0.027) |
| $outputgap_{it-1}$ | 0.103*** (0.037) | 0.121*** (0.038) | 0.113*** (0.038) | 0.098*** (0.037) | 0.115*** (0.039) |
| $m3_{it-1}$ | -0.004 (0.003) | -0.005 (0.003) | -0.006* (0.004) | -0.006 (0.004) | -0.003 (0.004) |
| dmt_{it} | -1.220*** (0.24) | - | - | - | - |
| $dsgrp_{it}$ | - | -1.098*** (0.243) | - | - | - |
| dez_{it} | - | - | -0.777*** (0.196) | - | -0.646*** (0.192) |
| $crisis_{it-1}$ | - | - | - | -0.606*** (0.143) | -0.566*** (0.142) |
| Obs | 513 | 513 | 513 | 499 | 499 |
| R^2 | 0.887 | 0.884 | 0.882 | 0.880 | 0.882 |
| Adj. R^2 | 0.886 | 0.883 | 0.881 | 0.879 | 0.881 |
| D-W stat | 2.099 | 2.033 | 2.025 | 2.009 | 1.981 |
| Hausman prob | 0.2769 | 0.3939 | 0.7887 | 0.8201 | 0.6436 |

Notes: *, ** and *** represent statistical significance at 10%, 5% and 1% levels, respectively. The robust standard errors are in brackets. *Obs* represents the total number of observations. *D-W stat* is the Durbin-Watson statistic. *Hausman prob* refers to the probability reached in the Hausman test.

Table 13

OLS estimation of institutional variables' effect on fiscal policy with $capb_{it}$ as
dependent variable: 1970-2012

| Test | (1) | (2) | (3) | (4) | (5) |
|-----------------|---------------------|---------------------|----------------------|---------------------|----------------------|
| c | -0.406* (0.215) | -0.363* (0.217) | -0.398* (0.217) | -0.307 (0.239) | -0.224 (0.232) |
| $capb_{it-1}$ | 0.823*** (0.075) | 0.824*** (0.076) | 0.815*** (0.074) | 0.818*** (0.077) | 0.812*** (0.077) |
| $debt_{it-1}$ | 0.012*** (0.003) | 0.012*** (0.003) | 0.013*** (0.003) | 0.010*** (0.003) | 0.012*** (0.003) |
| dmt_{it} | -0.247 (0.19) | - | - | - | - |
| $dsgp_{it}$ | - | -0.378** (0.191) | - | - | - |
| dez_{it} | - | - | -0.625*** (0.200) | - | -0.626*** (0.209) |
| $crisis_{it-1}$ | - | - | - | -0.326** (0.15) | -0.293** (0.140) |
| Obs | 428 | 428 | 428 | 414 | 414 |
| R^2 | 0.679 | 0.681 | 0.686 | 0.680 | 0.687 |
| Adj. R^2 | 0.677 | 0.679 | 0.683 | 0.678 | 0.684 |
| D-W stat | 2.044 | 2.053 | 2.066 | 1.971 | 2.003 |
| Hausman prob | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

Notes: *, ** and *** represent statistical significance at 10%, 5% and 1% levels, respectively. The robust standard errors are in brackets. *Obs* represents the total number of observations. *D-W stat* is the Durbin-Watson statistic. *Hausman prob* refers to the probability reached in the Hausman test.

Table 14

OLS-FE estimation of institutional variables' effect on monetary policy with $interest_{it}$ as dependent variable: 1970-2012

| Test | (1) | (2) | (3) | (4) | (5) |
|--------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| c | 2.280*** (0.484) | 1.984*** (0.463) | 1.476*** (0.422) | 0.941** (0.419) | 1.087*** (0.426) |
| $interest_{it-1}$ | 0.738*** (0.032) | 0.697*** (0.038) | 0.737*** (0.034) | 0.783*** (0.029) | 0.741*** (0.034) |
| $inflation_{it-1}$ | 0.111*** (0.029) | 0.158*** (0.029) | 0.165*** (0.029) | 0.201*** (0.028) | 0.199*** (0.028) |
| $outputgap_{it-1}$ | 0.106*** (0.037) | 0.134*** (0.040) | 0.120*** (0.039) | 0.102*** (0.038) | 0.127*** (0.040) |
| $m3_{it-1}$ | -0.005 (0.004) | -0.003 (0.004) | -0.005 (0.005) | -0.004 (0.005) | -0.003 (0.004) |
| dmt_{it} | -1.467*** (0.250) | - | - | - | - |
| $dsgp_{it}$ | - | -1.384*** (0.267) | - | - | - |
| dez_{it} | - | - | -0.997*** (0.244) | - | -0.970*** (0.241) |
| $crisis_{it-1}$ | - | - | - | -0.647*** (0.146) | -0.607*** (0.145) |
| Obs | 513 | 513 | 513 | 499 | 499 |
| R^2 | 0.888 | 0.885 | 0.883 | 0.881 | 0.882 |
| Adj. R^2 | 0.884 | 0.881 | 0.878 | 0.876 | 0.881 |
| D-W stat | 2.082 | 2.012 | 2.008 | 2.015 | 1.981 |
| Hausman prob | - | - | - | - | - |

Notes: *, ** and *** represent statistical significance at 10%, 5% and 1% levels, respectively. The robust standard errors are in brackets. *Obs* represents the total number of observations. *D-W stat* is the Durbin-Watson statistic. *Hausman prob* refers to the probability reached in the Hausman test.

Table 15

OLS-FE estimation of institutional variables' effect on fiscal policy with $capb_{it}$ as dependent variable: 1970-2012

| Test | (1) | (2) | (3) | (4) | (5) |
|-----------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| c | -1.429*** (0.311) | -1.382*** (0.313) | -1.416*** (0.312) | -1.297*** (0.337) | -1.282 (0.343) |
| $capb_{it-1}$ | 0.745*** (0.090) | 0.746*** (0.092) | 0.738*** (0.090) | 0.732*** (0.096) | 0.733*** (0.097) |
| $debt_{it-1}$ | 0.032*** (0.005) | 0.030*** (0.005) | 0.031*** (0.005) | 0.028*** (0.006) | 0.031*** (0.006) |
| dmt_{it} | -0.493** (0.198) | - | - | - | - |
| $dsgp_{it}$ | - | -0.511** (0.206) | - | - | - |
| dez_{it} | - | - | -0.717*** (0.218) | - | -0.682*** (0.227) |
| $crisis_{it-1}$ | - | - | - | -0.306** (0.155) | -0.258** (0.147) |
| Obs | 428 | 428 | 428 | 414 | 414 |
| R^2 | 0.707 | 0.708 | 0.711 | 0.706 | 0.687 |
| Adj. R^2 | 0.695 | 0.697 | 0.700 | 0.694 | 0.684 |
| D-W stat | 2.041 | 2.048 | 2.061 | 1.953 | 2.003 |
| Hausman prob | - | - | - | - | - |

Notes: *, ** and *** represent statistical significance at 10%, 5% and 1% levels, respectively. The robust standard errors are in brackets. *Obs* represents the total number of observations. *D-W stat* is the Durbin-Watson statistic. *Hausman prob* refers to the probability reached in the Hausman test.

Table 16

Estimation of the effects of different types of crises (dummy variables) on monetary and fiscal policies: 1970-2012

| Policy | Monetary Policy | | | Fiscal Policy | | |
|--------------------|---------------------|---------------------|---------------------|----------------------|----------------------|----------------------|
| Dependent Variable | $interest_{it}$ | | | $capb_{it}$ | | |
| Method | OLS | OLS-FE | 2SLS | OLS | OLS-FE | 2SLS |
| c | 1.053*** (0.377) | 1.169** (0.462) | 1.071** (0.437) | -0.520** (0.245) | -1.519*** (0.345) | -1.635*** (0.366) |
| $interest_{it-1}$ | 0.799*** (0.029) | 0.795*** (0.028) | 0.799*** (0.037) | - | - | - |
| $inflation_{it-1}$ | 0.125*** (0.025) | 0.127*** (0.028) | 0.130*** (0.034) | - | - | - |
| $outputgap_{it-1}$ | 0.013 (0.045) | 0.009 (0.046) | 0.017 (0.046) | - | - | - |
| $m3_{it-1}$ | -0.010** (0.004) | -0.012** (0.006) | -0.011** (0.005) | - | - | - |
| $capb_{it-1}$ | - | - | - | 0.906*** (0.052) | 0.817*** (0.083) | 0.785*** (0.095) |
| $debt_{it-1}$ | - | - | - | 0.010*** (0.003) | 0.027*** (0.006) | 0.029*** (0.006) |
| dbc_{it} | -0.279 (0.264) | -0.277 (0.277) | -0.333 (0.276) | -1.119*** (0.361) | -1.288*** (0.325) | -1.372*** (0.324) |
| dcc_{it} | -0.036 (0.294) | 0.009 (0.302) | -0.074 (0.297) | 0.206 (0.328) | 0.371 (0.349) | 0.358 (0.355) |
| dic_{it} | 2.172** (1.035) | 2.230** (1.049) | 2.090** (1.055) | 1.106* (0.597) | 1.393** (0.629) | 1.238* (0.640) |
| $dsmc_{it}$ | 0.920*** (0.212) | 0.955*** (0.215) | 0.974*** (0.220) | 0.235 (0.216) | 0.431** (0.204) | 0.480** (0.205) |
| Obs | 483 | 483 | 467 | 398 | 398 | 384 |
| R^2 | 0.878 | 0.879 | 0.878 | 0.725 | 0.745 | 0.744 |
| Adj. R^2 | 0.876 | 0.873 | 0.876 | 0.721 | 0.733 | 0.730 |
| D-W stat | 1.963 | 1.965 | 1.974 | 1.756 | 1.740 | 1.716 |
| Hausman prob | 0.9196 | - | 0.9514 | 0.0007 | - | 0.0084 |

Notes: *, ** and *** represent statistical significance at 10%, 5% and 1% levels, respectively. The robust standard errors are in brackets. *Obs* represents the total number of observations. *D-W stat* is the Durbin-Watson statistic. *Hausman prob* refers to the probability reached in the Hausman test. We carried out the Wald test in order to test for multiple exclusion restrictions. Whilst we did not reject the null-hypothesis, which is that crises are not statistically significant, depending on each policy and method used.